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## EFFECT OF SMOKING AND SUN DRYING ON PROXIMATE COMPOSITION OF *Diplotaxodon* FISH SPECIES (NDUNDUMA) FROM LAKE MALAWI, MALAWI

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## ABSTRACT

Processed fish and fish products have high nutritional value, longer shelf life and fetch better prices on the market in contrast to freshly caught fish which are highly perishable. Processing, however, alters nutrient composition of a product underpinning the need for caution when consuming processed products. The study analyzed the effect of traditional smoking and sun drying on proximate composition (moisture, protein, fat and ash) of *Diplotaxodon* species locally known as Ndunduma. This is an important commercial cichlid species harvested across the entire Lake Malawi by both artisanal and commercial fishers. Fresh *Diplotaxodon* fish samples were collected from fishers' boats in the south-western part of Lake Malawi, Malawi immediately after catch early in the morning. The fish were washed then weighed and thereafter, smoked in a traditional smoking kiln and sun dried on reed mats. Determined percent moisture, protein, fat and ash content for smoked fish were:  $12.22 \pm 0.05$ ,  $55.30 \pm 1.67$ ,  $25.31 \pm 2.78$  and  $12.96 \pm 0.72$ , respectively, while corresponding values for fish that were sun dried were:  $24.28 \pm 0.14$ ,  $52.80 \pm 1.28$ ,  $22.36 \pm 0.26$  and  $13.81 \pm 0.14$ , respectively. Overall, results show reduced protein content in processed fish (smoked and sun dried) ( $P < 0.05$ ) although not significantly different in smoked fish ( $P > 0.05$ ). Significantly low moisture content in smoked fish is indicative of a product with longer shelf life since moisture favours rapid microbial growth causing freshness quality deterioration. Although not significantly different, high fat ( $P > 0.05$ ) and ash ( $P < 0.05$ ) in smoked fish is consistent with a nutrient rich product. The study concludes that smoked *Diplotaxodon* species is more nutritious and may present better storage qualities than sun dried due to relatively low moisture. Caution should, nevertheless, be considered due to the high fat levels to prevent spoilage caused by breakdown of fats. Since smoked products are of high commercial value, fish processors should be encouraged to smoke fresh *Diplotaxodon* species other than sun drying.

**Key words:** *Diplotaxodon* species, Ndunduma, processing, proximate composition, Lake Malawi

## INTRODUCTION

*Diplotaxodon* are an important offshore species widely distributed across the entire Lake Malawi in Malawi, Southern Africa. The species is probably the most abundant of the cichlids in the lake with high biomass in the pelagic zone alone and is exploited commercially by both artisanal and commercial fishers [1]. It is, therefore, one of the major food fish providing nutrition to many Malawians. Fish are critical for the health and nutrition of Malawians, especially for rural communities and those living around the lakes [2, 3]. Fatty acids found in oily fish are essential for the development of the brain and body and are particularly crucial in the diets of babies, children, and of pregnant and lactating women [4]. In fact, consumption of omega-3 fatty acids during pregnancy reduces the risk of low birth weight, which is a key factor in both maternal and child mortality [5]. Fish contains nearly all essential nutrients important for people living with HIV/AIDS and related diseases that need good amounts of protein and energy rich foods together with vitamins and minerals to build their muscle and stay health [6]. In Malawi, fish are usually processed to extend shelf life and improve quality using the two most common and very old fish processing methods of sun drying and smoking. Sun drying is common during dry periods when relative humidity is low, while smoking is carried out any period of the year. Smoking reduces food spoilage but also modifies appearance, taste and smell of foods [7]. Processing, however, alters the nutritional composition of foods [8, 9, 10] underpinning the need to understand its effects on processed products. This study was carried out to determine the effect of the traditional processing methods (smoking and sun drying) on the nutrient composition of *Diplotaxodon* species (Ndunduma) harvested from south-western Lake Malawi, Malawi.

## MATERIALS AND METHODS

### Collection and processing of fish samples

Freshly caught *Diplotaxodon* (Ndunduma) fish were bought from fishers at Malembo beach in the south western arm of Lake Malawi, Malawi, Southern Africa. Fish were washed and grouped into three batches for smoking, sun drying and fresh (control). Ndunduma is a small sized fish species and as such, the fish were processed whole as it is done by processors without gutting or skinning. Drying was done by exposing the fish in the open sun for three days (Figure 1A).



**Figure 1: Sun drying of the fish samples (A) and smoking in a traditional smoking kiln (B) Fish were smoked using the traditionally constructed smoking kilns (Figure 1B) that are commonly used by fish processors in the area. Both fresh and processed fish samples were then analysed for nutrient composition (moisture, protein, fat and ash) in the laboratory**

### **Proximate analysis**

Proximate composition (moisture, crude protein, fat and ash) of the processed (smoked and sun dried) and fresh fish samples was determined in triplicate following a procedure by AOAC [11]. Protein was determined using the semi-micro Kjeldahl method. One gram of ground sample from each of the two samples (smoked and sun dried) was digested in a Kjeldahl flask using 98% Sulphuric acid and a catalyst made from Potassium sulphate and Cupric sulphate. The samples were distilled and the distillate titrated using 0.05M Sodium hydroxide (NaOH). Crude protein content was then determined as nitrogen and multiplied by 6.25 (Protein contains 16% nitrogen thus, 6.25 is 100/16). Fat content was determined using Soxhlet ether extraction. Petroleum ether was added to 2.0g sample of fish and placed in an extraction apparatus (a thimble). Extraction was carried out for 16 hours, after which the ether had evaporated to dryness and only fat remained in the flask. Fat content was obtained by subtracting the weight of the flask after drying from that before drying. To determine moisture, 1 gram sample of ground fish (for each of the two samples) was placed in a crucible and dried at 105 degrees Celsius to a constant weight after the initial weighing. Moisture content of the fish was calculated by subtracting the initial from the final weight of the fish sample. Ash was determined by grinding 2 grams sample (for each of the two samples) then placing it in a crucible. The samples were later ashed at 600 degrees Celsius for 5 hours in carbolite muffle furnace, then cooled to room temperature. The amount of ash was given by the difference in weight of the crucible before and after cooling.



### Data analysis

Data were analyzed in SPSS for Windows (Version 20.0). Treatment means for the fish processing methods were compared using one-way analysis of variance (ANOVA) at 95% level of significance. Significantly different treatment means were separated using Duncan's Multiple Range Test (DMRT).

## RESULTS

The results of the proximate composition of the fresh, smoked and sun dried Ndunduma are presented in Table 1 expressed as mean  $\pm$  Standard Deviation (SD) of the triplicate determinations. There were significant differences ( $P < 0.05$ ) in the mean moisture content among the three samples of fish with the highest being in the fresh Ndunduma followed by the sun dried then smoked. A significantly lower crude protein content ( $P < 0.05$ ) was recorded in sun dried Ndunduma than in fresh Ndunduma though it was not significantly different ( $P > 0.05$ ) from smoked fish. No significant differences ( $P > 0.05$ ) were recorded in the crude protein content of fresh and smoked Ndunduma. Crude fat was not significantly different ( $P > 0.05$ ) in the fresh and processed Ndunduma although the highest value was recorded in smoked Ndunduma. The ash content increased significantly ( $P < 0.05$ ) with processing and the highest value was recorded in sun dried Ndunduma followed by smoked Ndunduma.

## DISCUSSION

The recorded moisture content of fresh Ndunduma (72.9%) falls within the range reported by Davies and Davies [12] that fish are made up of 70-84% water which decreased with processing. Smoked Ndunduma retained the least moisture content than sun dried fish. This could be explained by the fact that during smoke drying, the flesh loses a lot of water and, in addition, a protective coating is formed due to partial carbonization of the tissues and other components by wood smoke [8]. On the contrary, sun dried fish tend to moisturize ambient air humidity, a situation which is restricted by the protective coating formed in smoked fish [8]. Adequate drying creates unfavorable conditions for growth of microorganisms [13], which would subsequently lead to prolonged shelf life of the fish.

Reduction in protein content during smoking in this study, although not statistically significant, has been reported by several authors [14, 15, 16]. Crude protein in fish is reduced by chemical reactions that occur during smoking [14]. In addition, the decrease in protein level in smoked fish could be as a result of the direct heat that was used to dry the fish (pers. obs.). According to Ravichandran *et al.* [17], protein forms the largest component of dry matter in fish. Fish is consumed as a major and valuable protein source in Malawi and as such, it is important that the protein content not be compromised during processing and preparation. In sun dried Ndunduma, the decrease in crude protein content could also be attributed to the time that the fish spends in the drying process, which could give chance to microbial contamination causing degradation of the protein molecules [18]. Apart from presenting favourable conditions for microbial growth, the

prolonged period that the fish spent during sun drying could also accelerate enzymatic breakdown of the proteins [8].

The increase in fat content after smoking could be due to the fact that fat content increases with drying of fish since the elimination of moisture due to heating concentrates ash and fat content in the fish [19]. The low value of fat content in sun dried Ndunduma can be attributed to oxidation due to the prolonged drying period [20]. Fish contains chiefly unsaturated fatty acids that are easily oxidized by atmospheric oxygen and high temperature or exposure to light can also increase the oxidation rate [21]. While smoked Ndunduma may present a product with a longer shelf life due to the low moisture content, the fish's high fat content, although nutritionally good, is a cause for concern. Fatty fish spoil rapidly due to fat oxidation thereby compromising the freshness quality of the product, hence caution needs to be exercised to prevent breakdown of the fats in storage [22, 23].

In this study, fresh Ndunduma recorded an ash content of  $10.57 \pm 0.51\%$ , an indication that it is a good source of minerals hence nutritious [24]. Ndunduma is among lean fish species which are generally considered to contain high ash levels [25]. Results generally showed an increase in the ash content of the processed samples agreeing with earlier studies [9] that ash content increases with dry processing in fish. The high ash values in the processed fish could also be due to contamination with sand and dirt during drying and transportation [13]. Fapohunda and Ogunkoya [26] reported that smoke drying methods increase ash and fat contents, which is also necessitated by the loss of humidity.

## CONCLUSION

Based on this study results, it is concluded that processed Ndunduma (smoked and sun dried) retains nutrients the most and eliminates significant moisture which would provide an ideal substrate for microbial growth. As a major source of dietary animal protein, smoked Ndunduma should be promoted as a way to effectively increase the shelf life of the fish while enhancing the flavour.

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**Table 1: Mean percent values of proximate composition (moisture, protein, fat and ash) of smoked and sun dried *Diplotaxodon* species (Ndunduma)**

Processing method	Nutrient (%)			
	Moisture	Protein	Fat	Ash
Fresh	72.91±1.03 <sup>a</sup>	58.86±2.84 <sup>a</sup>	24.18±0.67 <sup>a</sup>	10.57±0.51 <sup>c</sup>
Smoked	12.22±0.05 <sup>c</sup>	55.30±1.67 <sup>ab</sup>	25.31±2.78 <sup>a</sup>	12.96±0.72 <sup>b</sup>
Sun dried	24.28±0.14 <sup>b</sup>	52.80±1.28 <sup>b</sup>	22.36±0.26 <sup>a</sup>	13.81±0.14 <sup>a</sup>

Means with the same superscript in a column are not significantly different (P>0.05)

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